Solar Montgolfiere Balloons for Mars

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Abstract

Until now, the only practical balloon systems proposed to explore the martian atmosphere have been superpressure balloons, which fly at a constant altitude, or short-lived helium balloons, which precariously drag a snake through all types of surface weather, or a day/night combination of the two. A novel atmospheric balloon system, known as a solar "Montgolfiere", now appears quite viable for *controlled* balloon landings at selected martian surface locations. This balloon could soft-land payload packages, such as science instruments or even lightweight surface roving vehicles. "Montgolfiere" balloons are named after the 18th-century French brothers Joseph-Michel and Jacques-Etienne Montgolfiere, who first flew hot-air balloons. Using entirely solar heat, they are ideal for landing at the martian poles during summer or for shorter flights at lower latitudes. Recent tests have already confirmed the ease of high-altitude deployment and filling of these solar hot-air balloons. Furthermore, actual landings and reascents of solar hot-air balloons have been recently demonstrated by JPL, using a novel, lightweight, top air vent that is radio controlled.

One particularly useful application of these balloons is their use as a parachute to soft-land packages that are 30% to 50% of the total entry mass, which represents at least a threefold improvement over present retro-rocket landing systems for small payloads, and eliminates the need for a retro-rocket landing system. Of particular interest is the solar Montgolfieres anticipated ability to soft-land about 15kg of instruments for the French CNES Ariane 5 piggyback missions to Mars, which allow for about 50kg entry mass

A number of low altitude and high-altitude tests on Earth have now confirmed the use of solar Montgolfieres for use in the martian atmosphere. During 1997, a series of low-altitude tests in Southern California confirmed altitude controllability and landing ease of deployment, as well as rapid filling and heating to obtain buoyancy. In 1998, a series of high-altitude tests at 30-35 km (8–10 mbar pressure) have confirmed deployment of 6-8 meter diameter balloons at martian-like atmospheric densities. Materials for the balloon envelopes are black polyethylene or 6 micron aluminized mylar with a scrim material. In 1999, full-sized, 15-meter diameter balloons will be tested at high altitude to confirm deployment and buoyancy capabilities for an actual Ariane 5 piggyback Mars mission.

One Mars piggyback mission which is being actively considered is to land a Gas Chromatograph Mass Spectrometer (GCMS) with a drilling arm to sample subsurface Mars material for traces of past or present life. Another possible mission is to soft-land an inflatable rover that would have a mass similar to Pathfinder's Sojourner, but would have greatly increased speed and range.